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Simulating the Illuminance and Efficiency of the LEDs Used in General Household Lighting

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Abstract

The advantage of the LEDs illumination in general household lighting was proposed. High efficiency white LED as the light source was provided the energy saving illumination of the general household lightings. Different spaces in general household with different standards of average illuminance were designed and simulated by LightTools and DIALux software. The power consumptions and efficiency of traditional illuminated light sources and LED light source in lighting the household environment were analyzed and compared with each other at the same standard of average illuminance. Finally, it provided the advantage of using white LEDs in different spaces of the general household lighting.

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Keywords: white light LED, lighting, household illumianation, fluorescent lamp, reflector

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1. Introduction

Rapid development of the efficiency of high power LED has been improved during these several decade, variety of LED applications gave us different vision in lighting design. The advantages of LED means they can now surpass the traditional light sources [1]. Furthermore, updated legislation which demands consideration of the environmental impact of a product over its life cycle, from production to disposal, makes LED the ideal candidate for an environmentally-friendly light source [2]. Numerous tiny glowing LED indicators are utilized in modern households for transmitting signals or information from electronic equipment [3]. Increasingly, automobiles are also being equipped with LED indicators and brake lights. Recently LED head lights have been designed for use in concept cars [4], and rapid improvements in white LEDs, such as Street lights, have been made the multi-billion dollar lighting market in the world. These changes and worldwide development of LED based illumination systems should make it possible for LEDs to be used in interior household illumination in the near future [5-8].

2. Experiments

During these several decades, fluorescent lights have become commonly used for daily illumination. The luminaires for fluorescent light are varied. The most commonly used in our households are compact fluorescent lamps. In the other hand, the development of LED techniques means that traditional illumination sources such as fluorescent lamps are no longer suitable. This is why in this study we develop the comparison for the twist-shape compact fluorescent lamp and white light LED.

In these experiments, Philips T3-24W/W twist-shape compact fluorescent lamp (with 24W and 1680 lm performance) were used as a single light source in our household illumination experiments. Besides, we simulated the performance of three different LEDs in lighting the household environment, which are listed in Table 1. We could obtain the candle power distribution profile from the Philips Lumileds website and designed with different types of reflectors by LightTools optical software.

After building the light source models, the spatial model of this study is a two-floor house, which has a porch space, living room, dining room, children's room, parents' room, reading room, master room, and the kitchen. The vertical views of all the different areas are as shown in Fig.1. Considering about the different purpose of different areas, we designed and simulated the illumination which followed the required standard that made by Chinese National Standards (CNS) [9] for our residential lighting. The simulated average illuminances and the required standard average illuminances of different areas are listed in Table 2, respectively, and the simulated results are all above the required standard.

By providing different LED reflector designing profiles for every room area, we also simulated the 3-D lighting in different room areas by DIALux software, which shown in Fig. 2.

Table 1. Parameters of three different LEDs

	LED 1	LED 2	LED 3
Type	Lumileds LXML-PW51	Lumileds LXM3-PW51	Lumileds LXM3-PW71
Typical Viewing Angle (degree)	120	120	120
Nominal CCT (K)	4000	4000	3000
Typical CRI (Ra)	70	85	85
Typical Lumino Flux (lm)	105	85	77
Power (W)	1.05	1.05	1.05
Efficiency (lm/W)	100	80.95	73.33
Proper Area	Living room, parents' room, and reading room	Kitchen and dining room	Master room and children's room

Fig. 1. The vertical views of different areas in the spatial model.

Table 2. Illuminances of different areas inside the house model

	Required standard Ave. illuminance	Simulated Ave. illuminance
Porch Area	75~150 lux	97.21 lux
Living room Area	150~300 lux	280.70 lux
Dining room Area	200~500 lux	328.09 lux
Kitchen Area	200~500 lux	348.83 lux
Reading room Area	50~100 lux	93.54 lux
Master room Area	30~75 lux	73.53 lux
Children's room Area	100~300 lux	144.97 lux
Parents' room Area	100~200 lux	149.55 lux

Fig. 2 The 3-D lighting simulation in (a) porch area, (b) living room area, (c) dining room area, (d) kitchen area, (e) reading room area, (f) master room area, (g) children's room area, and the (h) parents' room area.

Calculate and compare with the electricity charge of twist-shape compact fluorescent lamp and LEDs with the same standard illuminance when we carry out the simulation with twist-shape compact fluorescent lamps and white light LEDs to reach the standard illuminance in different household lighting environments.

For the common twist-shape compact fluorescent lamp, the consumption for lighting a single tube is 24W. In another case, the consumption for lighting a single LED is 1.05W. So, we can finally calculate that the power consumption for LEDs illumination is less than that for twist-shape compact fluorescent lamps. The power consumption for different area of illumination are listed in Table 3. The advantages of LEDs illumination are very clear.

Table 3. Power consumption for different illumination

	Twist-shape compact florescent lamps	White light LEDs
Porch area	48 W	25.2 W
Living room area	144 W	100.8 W
Dining room area	72 W	12.6 W
Kitchen area	120 W	63 W
Reading room area	96 W	33.6 W
Master's room area	96 W	46.2 W
Children's room area	96 W	94.5 W
Parents' room area	168 W	84 W

3. Results and discussion

In this study we simulated and analyzed twist-shape compact fluorescent lamp and LED light source in household illumination. Simulating with the same required standard illuminance, we could find the most advantageous LED lighting design and benefits that comparing with the traditional twist-shape compact fluorescent lamp in household lighting. In addition, the LightTools optical software and the DIALux software allowed us to easily simulate the illuminance and 3-D virtual reality. Finally, we point out the possibility of using LED designs for household illumination in the near future.

4. Acknowledge

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